

CLAIMS:

1. A bone fixation assembly comprising:
 - a fixation element having a head portion;
 - a unitary coupling element having a first bore having an axis, the first bore adapted to receive the head portion of the fixation element and to permit axial, sliding movement of the coupling element relative to the fixation element, the coupling element having a second bore adapted to receive a spinal rod;
 - a first locking element adapted to secure the head portion in the first bore; and
 - a second locking element adapted to secure the spinal rod in the second bore.
2. The assembly of claim 1, wherein the first locking element comprises a locking nut.
3. The assembly of claim 2, wherein the first locking element further includes a ball ring that cooperates with the locking nut.
4. The assembly of claim 1, wherein said second bore has an axis transverse to the axis of the first bore.
5. The assembly of claim 1, wherein said second locking element is connected to said coupling element and cannot be removed from said coupling element after connection therewith.
6. The assembly of claim 5, wherein second locking element includes a flared lip that cooperates with a shoulder associated with the coupling element to prevent inadvertent removal of the second locking element.
7. The assembly of claim 5, wherein the first locking element is connected to said coupling element and cannot be

removed from said coupling element after connection therewith.

8. The assembly of claim 3, wherein the locking nut contains external male threads that engage female threads formed in the first bore.

9. The assembly of claim 8, wherein the ball ring is seated within the first bore and at least a portion of the locking nut circumferentially surrounds a portion of the ball ring.

10. The assembly of claim 9, wherein engagement of the male threads of the locking nut with the female threads in the first bore exerts radial force on the ball ring to secure the head of the fixation element in the first bore.

11. The assembly of claim 10, wherein the locking nut is in a locked position, and the ball ring is in contact with the coupling member and the locking nut.

12. The assembly of claim 11, wherein the second locking element includes a set screw.

13. The assembly of claim 12, wherein the set screw is permanently seated in the coupling member.

14. The assembly of claim 13, wherein the locking nut and ball ring are permanently seated in the first bore.

15. The assembly of claim 13, wherein the locking nut cannot be removed from said coupling element after connection therewith.

16. The assembly of claim 15, wherein a portion of the bore is tapered and the locking nut includes a tapered opening to permit polyaxial motion between the fixation element and the connector.

17. The assembly of claim 16, wherein the taper in the bore and the taper in the locking nut extend in opposite directions.

18. The assembly of claim 17, wherein the fixation element includes a screw.

19. A bone fixation assembly comprising:

a fixation element having a substantially cylindrical head portion;

a unitary coupling element having a first bore adapted to receive the head portion of the fixation element, and a second bore adapted to receive a spinal rod;

a first locking element pre-assembled with the coupling member and adapted to secure the head portion in the first bore; and

a second locking element pre-assembled with the coupling member and adapted to secure the spinal rod in the second bore.

20. The bone fixation assembly of claim 19, wherein the first bore permits axial movement of the coupling element relative to the fixation element.

21. The bone fixation assembly of claim 20, wherein the first bore permits polyaxial movement of the coupling element relative to the fixation element.

22. The bone fixation assembly of claim 21, wherein the first bore has an axis, and the second bore has an axis transverse to the first bore.

23. The assembly of claim 19, wherein the first locking element includes a ball ring seated in the first bore that cooperates with a locking nut threaded in the first bore.

24. The assembly of claim 20, wherein the locking nut is adapted to exert radial force on the ball ring.

25. A bone fixation assembly comprising:

a fixation element having a head portion;

a unitary coupling element having a first bore adapted to receive the head portion of the fixation element and to permit axial movement of the coupling element relative to the fixation element; and

a locking element including a ball ring and a locking nut associated with the head portion adapted to exert a radial force on the ball ring such that the ball ring exerts a compressive force on the head of the fixation element to secure the head of the screw in the coupling element.

26. A bone fixation assembly comprising:

a fixation element having a head portion;

a unitary coupling element having a first bore adapted to receive the head portion of the fixation element and to permit axial movement of the coupling element relative to the fixation element;

a compressible ball ring seated in the first bore adapted to secure the head of the fixation element to the coupling element when the ball ring is compressed; and

means for exerting compressive radial force on the ball ring.

27. The assembly of claim 26, wherein the means for exerting compressive radial force includes a locking nut.

28. The assembly of claim 27, wherein the locking nut contains external male threads adapted to engage internal female threads in the first bore.

29. A bone fixation assembly comprising:

a fixation element having a substantially cylindrical head portion;

a unitary coupling element having a first bore adapted to receive the head portion of the fixation element and to permit axial movement of the coupling element relative to the fixation element; and

a first locking element including a locking nut that engages the first bore and a tapered opening adapted to allow polyaxial motion of the head of a fixation element inserted therethrough.

30. The assembly of claim 29, wherein the locking nut cooperates with a ball ring to exert force on the head of the fixation element to lock the fixation element with respect to the coupling element.

31. A bone fixation assembly comprising:

a fixation element having a substantially cylindrical, smooth head portion;

a unitary coupling element having a first bore adapted to receive the head portion of the fixation element and to permit axial, sliding movement of the coupling element relative to the fixation element, the coupling element having a second bore adapted to receive a spinal rod;

a first locking element including an externally threaded locking nut adapted to cooperate with threads in the first bore and exert radial compressive force on a ball ring pre-seated in the first bore to secure the head portion in the first bore, the locking nut permitting polyaxial motion of the fixation element; and

a second locking element pre-assembled with the coupling member and adapted to secure the spinal rod in the second bore.

32. A method of fixing a bone in place comprising:
attaching a fixation element having a head portion to a bone;

sliding a first bore of a unitary coupling element over the head portion;

inserting a rod through a second bore of the coupling element;

tightening a first locking element associated with the first bore to secure the head portion to the coupling element; and

tightening a second locking element associated with the second bore to secure the spinal rod to the coupling element.

33. The method of claim 32, wherein the bone comprises a vertebra.

34. The method of claim 33, wherein the first locking element is tightened prior to tightening the second locking element.

35. The method of claim 33, wherein the second locking element is tightened prior to the first locking element.

36. The method of claim 33, wherein the first and second locking elements are pre-assembled with the coupling element.

37. The method of claim 33, wherein the second locking element comprises a set screw having a flared end that cooperates with a shoulder associated with the coupling element to prevent the set screw from becoming inadvertently removed from the coupling element.

38. The method of claim 33, wherein the first locking element comprises a locking nut and a ball ring that cooperates with the locking nut.